DISTRIBUTION PLANNING STANDARDS

LOAD FORECAST GUIDELINE
(Version 1.0)

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1.0 INTRODUCTION

In order to plan an electric power delivery system, the planner must know how much power it will be expected to serve, and where and when that power must be delivered. Such information is provided by *a load forecast*, a prediction of future electric demand that includes location (where) as one of its chief elements, in addition to magnitude (how much) and temporal (when) characteristics.

The load forecast represents the starting point for much of the planning activity. It also plays an important role in system planning as well as reinforcement and expansion of electrical networks.

Rapid growth in the electric power distribution network necessitates the need for more accurate and reliable forecasts. The Kingdom of Saudi Arabia has experienced very rapid expansion over the past two decades in response of the increased infrastructure development and fast growth and development of urban areas.

This document has been developed as a guideline to prepare a medium-term load forecast for distribution network in Saudi Electricity Company (SEC). It consists of following main sections:

- Important elements of load forecast.
- Flow chart and timing of load forecast process.
- Required input data.
- Peak load assessment of grid stations, main distribution substation, and feeders.
- Load forecast process and analysis.
- Load forecast reports.

2.0 DEFINITIONS

This section shows definitions and clarifications of some of terminologies mentioned in the whole guideline in order to have clear unified understanding.

2.1. Coincident Factor (C.F)

The ratio of the maximum demand of the load as a whole measured at its supply point to the sum of the maximum demands of the component parts of a load measured in a specific period of time. Coincident factor is normally less than unity depending upon the nature and behavior of load. It is the reciprocal of Diversity Factor.

$$C.F = \frac{\text{Maximum Demand of the Load as a Whole}}{\text{Sum of Maximum Demands of its Component Parts}}$$

2.2. Coincident Demand

Sum of two or more demands that occur in the same demand interval.

2.3. Non-Coincident Demand/Loads:

Sum of the individual maximum customer loads (or demands) measured at different locations at whatever time each location reaches the maximum.

2.4. Peak Demand, Peak Load

These two terms are used interchangeably to denote the maximum power requirement of a system at a given time (e.g. an hour, a day, a month, a season or a year).

2.5. Peak Assessment

Judgment and fixation of the value or amount of load which is genuine and actual peak after analyzing a whole year peak readings to filter abnormal data which might be due to shifting of load during contingency or because of human or device errors.

2.6. Load Growth

Increase in energy demand. Load growth occurs either through natural growth of an area or group of customers resulting from increased prosperity, productivity or population growth or through stimulation of the energy market.

2.7. Load Transfer

The management of distribution demand load during peak demand period is referred to as load transfer. The primary function of load transfer is the reduction of load in one or more transformers or feeders to balance total system demand load with the available supply.

2.8. Spot Load

A load that is different in magnitude from the surrounding normal area loads. A bulk customer (whose load greater than 1.0 MVA) is usually considered as a spot load.

2.9. Plot Plan

A new developed area.

2.10. SCADA/LDC

SCADA refers to Supervisory Control And Data Acquisition, while LDC refers to Load Dispatch Center.

2.11. Substation

The aggregate of electrical equipment and facilities, by which electrical power is transformed in bulk from one voltage to another service transformers.

In this guideline, two types of substations are repeatedly mentioned, which are:

Grid Station: refers to a substation that has a primary voltage at transmission level and secondary voltage at distribution level (e.g. 230/69 kV, 230/34.5 kV, 132/33 kV, 132/13.8 kV, 115/69 kV, 110/13.8 kV …).

Main Distribution Substation: refers to a substation that has primary and secondary voltages at the highest and medium classes of voltages at distribution levels (e.g. 69/13.8 kV, 34.5/13.8 kV, 34.5/11 kV, 33/13.8 kV …).

In this guideline, if the term “substation” is solely used, it refers to both above types.

2.12. Transmission and Distribution (Electrical System)

Definitions and nomenclature defining “transmission” and “distribution” vary greatly among different countries, companies, and power systems.

For the purpose of this guideline, transmission is any voltage equal and above 110 kV, while distribution is any voltage below 110 kV.

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3.0 SCOPE

This document is intended to serve as a guideline for developing a medium range load forecast for distribution sector, covering all the main components of distribution network:

- Grid stations (230/69 kV, 230/34.5 kV, 132/33 kV, 132/13.8, 115/69 kV, 115/34.5 kV, 115/13.8 kV, 110/33 kV, 110/13.8 kV).
- Main distribution substations (69/13.8 kV, 34.5/13.8 kV, 34.5/11 kV, 33/13.8 kV).
- Outgoing feeders (34.5 kV, 33 kV, 13.8 kV, 11 kV).
- Isolated areas that are under jurisdiction of Distribution Sector.

4.0 IMPORTANT ISSUES RELATED TO LOAD FORECAST

This section highlights some important issues related to load forecast process such as forecasting accuracy, forecasting range and various methodologies used for development of load forecast.

4.1. Forecasting Accuracy

Load forecasting is an important function in planning and operation of an efficient electric power system. The better the forecast, the better would be the justification to invest as capital cost. There could be two scenarios: " Over estimation" of the load forecast would depict higher than the actual demand, resulting in planning of additional facilities which otherwise are not necessary. " Under Estimation" of the load forecast would depict lower than the actual demand, missing planning of additional facilities which otherwise are necessary. It could result in delaying power supply to new customers as well as exhibit poor quality of power supply to the existing customers.

Accuracy is naturally a concern in any forecasting situation particularly in the medium and short-range planning time frames. To determine how well a particular load forecast would satisfy future transmission and distribution requirements, it is necessary to determine how well the answer to the

following three basic questions is provided by the planner; “Where the power is required?”, “How much power is required?”, and “When the power is required?”. A forecast or plan can be quite correct with reference to the amount and timing of the additional demand but could be quite inaccurate with reference to the location where this power is required. Same thing applies if one of the other factors (Amount of Demand or Timing of the Demand) comes out to be inaccurate.

In view of the above, an error margin of ± 5% could be considered acceptable in all forecasting levels.

4.2. Forecasting Range

The load forecast can be developed in a long, a medium or a short-term range.

The long-term load forecast is normally for more than 15 years range. The medium-term ranges from 5 to 10 years. While the short-term load forecast can be developed annually, monthly, weekly, daily, or even hourly.

For the Distribution System, where accurate information of city development in the kingdom is not available, it is advisable for the time being to go for a medium range forecasting (5-years) method. However, load forecasting could be done on long Rang basis (10-15 years) for planning Transmission and Generation facilities which require a longer lead time due to budgeting, Development of SOW/TS, acquisition of ROW and longer construction period.

One purpose of the Medium-range planning is to assure that lead-time requirements are met for the different types of projects. The output of the medium-range planning process is a set of decisions and specification for future change to the system.

The set lead-time for system additions should not be allowed to slip. Therefore, what is mostly needed in medium-range planning is to set up a reliable “alarm” about when present facilities will become insufficient.

Long-range planning needs are somewhat different. No commitment needs to be made to the elements in a long-range plan, so timing is less important than in medium-range planning. Since the long-range plan evaluates whether and how medium-range commitments fit well into long-range needs, capacity and location are more important than timing. Unlike medium & short-range planning, long-range transmission and distribution planning requirements for a load forecast are oriented less toward " when" and more toward "how much". For long-range planning, knowing what will eventually be needed is more important than knowing exactly " when the demand will actually appear."

4.3. Demand Forecast Methodologies

Several methods are being used for the electric load forecasting. They can generally be categorized on one of two basic themes: trending, which involves extrapolating past load growth into future, or simulation, which involves modeling the process of load growth itself. Although simulation is the newer, and generally more effective, of the two, no single forecasting technique is best for all applications, and trending methods are recommended in certain circumstance.

Trending Methods

Trending methods work with historical load data, extrapolating past load growth patterns into the future. The most common trending method, and the method most often thought of as representative of trending in general, is polynomial curve fitting, using *multiple regression* to fit a polynomial function to historical peak load data and then extrapolating that function into the future to provide the forecast. The modified *multiple regression* method to consider some dynamic factors such as load transfer and unusual spot loads, is recommended to be used in SEC. This method will be explained in detailed in section 8.2.

Simulation Method

Simulation-based distribution load forecasting attempts to reproduce, or model, the process of load growth itself in order to forecast where, when,

and how load will develop, as well as to identify some of the reasons behind its growth. In contrast to trending methods, simulation uses a completely different philosophy, requires more data, and works best in a very different context. It is best suited to high forecast resolution (very small area), long-range forecasting, and ideally matched to the needs of multi-scenario planning. Most important, when applied properly, it can be much more accurate than the best trending techniques. Examples of the simulation method are ANN and Fuzzy method.

5.0 FLOW CHART AND TIMING OF LOAD FORECAST PROCESS

Flow chart is prepared as an overview and as a quick reference for the major steps in the load forecasting process. Also, a table representing parties responsible for the major steps and corresponding due dates is created. (Refer to **Appendixes A & B**)

5.1. Flow Chart

In this section, a brief description about the major steps of load forecast is introduced. The detailed explanation of each activity can be referred to the appropriate section of this guideline.

5.1.1 Data Collection

Data collection is a vital activity in the load forecast process as correctness of information is required to have a realistic output. Different types of data are required for the load forecast process. Details of this data, its sources and its importance are explained in *section 6*.

5.1.2 Assessment of Substations and Feeders Peak

In this activity, recorded peak readings of grid stations, main distribution substation, and feeders are analyzed and the maximum peaks are then assessed. Detailed methods/ techniques of peak assessment are explained in *section 7*.

5.1.3 Load Forecast Process and Analysis

Different parameters are considered in load forecast process. These parameters are incorporated through an excel-based program. Details of load forecast methods/techniques and parameters are discussed in s*ection 8*.

5.1.4 Reporting of Substations and Feeders Load Forecast

In this activity, load forecast reports of grid station and main distribution substation are prepared based on the output of load forecast process and analysis. Operating Areas shall then sent these reports to Planning Department/Distribution Services (PD/DS) for review and consolidation. Details of formats and sequence of report is explained in *section 9.*

5.1.5 Report Review and Consolidation

Load forecast reports shall be reviewed and consolidated by PD/DS in order to have a comprehensive final report that shall be submitted to Transmission Sector.

5.1.6 Submitting of Final Report to Transmission Sector

After review by PD/DS, final report of load forecast of transmission substations is to be submitted to Transmission Sector by the mid of January of the following year.

5.2 Timing

Due to variety of weather conditions in the Kingdom, two scenarios are considered with regards to collection of data particularly peak load of feeders, main distribution substations, and grid stations. The first which is **Normal Scenario**, for areas where summer is the peak period and second which is **Special Scenario** where peak period occurs during winter, covering areas as mentioned in Table 1 below:

Table 1: Areas with Peaks During Winter

Operating Area	Electricity Departments	Division	Units
SOA	Asir	Asir	All Asir units, except Tathleeth, Muhayil, Majardah and Al Birk
		Bisha	Al Nimas and Al Alaya
	Baha	Baha	All Al Baha units, except Mikwah and Qilwah
WOA	Tabuk	Tabuk	All units
EOA	Jouf & Northern Borders	Qurayyat	Qurayyat & Tabarjal
COA	Hail		All units

Religious occasions, such as Ramadan and Hajj, which also affects load forecast process with regards to Gregorian calendar are considered as special scenario. Refer to **Appendixes C1 & C2** for timing of the mentioned religious occasions.

Following are activities and due dates for both scenarios:

5.2.1 Data Collection of Substations and Feeders Peak Load Readings

This is a continuous process for the whole year.

For normal scenario - *weekly readings shall be taken during summer peak period which is from **May** up to **September** while during off-peak period once a month is enough.*

For special scenario - *weekly readings shall be taken during winter peak period which is from **December** up to **February** while monthly readings shall be collected during remaining months.*

Other required data along with peak load of substations and feeders shall be ready by the end of September.

5.2.2 Assessment of Substations and Feeders Peak

Assessment of peak shall start in October. For normal scenario, assessment shall cover data collected from January up to September. While for special scenario, assessment shall be on data

collected from December (Previous Year) to September.

5.2.3 Load Forecast Process and Analysis

Load forecast process and analysis is recommended to start by October and results shall be ready by end of December, each year.

5.2.4 Reporting of Substations and Feeders Load Forecast

Operating Areas shall finalize and submit their load forecast reports to PD/DS by end of December, each year.

5.2.5 Review, Consolidate and Submission of final report

Final consolidated report shall be submitted to transmission sector by end of January of next year.

For each scenario, corresponding due dates of major activities of the load forecast process can be referred to table in ***Appendix B***.

6.0 REQUIRED INPUT DATA

Following information is essentially required for the development of 5-Year Load Forecast Reports:

1. Historical data.
2. Peak demand of feeders and the transformers of main distribution substation, and grid substation.
3. Customers forecast.
4. Spot load (bulk customers).
5. Distribution system improvement projects (5-Year Network Plan).
6. Schedule of on-going grid station and main distribution substation projects.
7. Future grid stations and main distribution substation projects.
8. Updated distribution network operational diagram.
9. Updated distribution network geographical layout.
10. Area layout drawings for plot plan development.

Moreover, following data might be also considered as necessary and upon the availability on each operating area:

- Load Management Programs/ Energy Conservation Programs.
- International/local events that might affect area electricity load.

6.1. Historical Data

Historical information about peak load of feeders, main distribution substations and grid stations is very important in the load forecast process. This data gives a picture of how was the trend of peak load on feeders and substations in the past years, through which future demand load can be forecasted considering other factors, such as bulk loads, load transfer between feeders, main distribution substations, and grid substations due to network modifications.

A considerable body of research has shown that when working with typical distribution network, the most recent six years of data give slightly better results than any other historical sample, including seven, eight, or more years of data. (H. Willis, Spatial Electric Load Forecasting)

If data is not available for certain substations or area, load trending style of nearby substation or area can be considered if the nature of the load is similar.

6.2. Peak Load Readings of Feeders and Substations Transformers

This data is required throughout the year on a routine basis. The load data, which comprises of substation Power Transformers and associated feeders, are recorded either manually by operators or automatically through SCADA/LDC link. Manual readings are taken in two different modes, i.e. for peak period and off-peak period. During peak period, weekly load readings are required. While during off-peak period, load readings are taken once a month. Peak period for the different scenarios is described in section 5.2 above.

Load readings shall be recorded in an electronic spreadsheet format **(Form 7).** Similarly, required data from SCADA/LDC shall be downloaded in the same format of **Form 7** for easier analysis of the readings.

6.3. Customers Forecast

Number of normal customers during the forecast period is one of the essential factors affecting the load demand forecast. Customer forecast per district or plot plan is required.

Form 8 shall be used to record forecasted number of customers in all districts/plot plans in each Electricity Department. Following information shall be included:

- Location or district name.
- Source of power supply (substations and feeder(s)).
- Plot plan number/name.
- Total number of lots.
- Anticipated total demand (KVA).
- Approved budget year.
- Start year of electrification.

- Average Area per lot (square meter).
- Estimated demand per lot (KVA).
- Number of lots electrified.
- Lots with coordination certificate not electrified.
- No. of lots electrified in the current year.
- No. of lots forecasted to be electrified in the following five years.

Summary of the total number of customers in each Electricity Department shall be also delivered.

6.4. Spot Load (Bulk Customers)

Customer having load of grater than 1 MVA is considered as a bulk load. All such customers shall be taken into account during load forecast because of their considerable effects on the future demand of the distribution network.

Identified bulk customers are to be filled in **Form 9** by Electricity Departments. Following data shall be included:

- Customer's name.
- Type of load (industrial, commercial, … etc.)
- Approved coordination certificate and power supply date.
- Existing load in MVA (contracted and demand) (if any).
- Supply voltage level.
- Year of energization for existing customers.
- Source of supply (substation and feeders).
- Ultimate load of the customer.
- Future load requirement in MVA (contracted and demand) along the span of the forecast period.

6.5. Distribution System Improvement Projects (5-Year Network Plan)

System improvement projects of distribution network during the forecast period shall be identified and considered in load forecast. These projects lead to load transfer between primary feeders and substations.

System improvement projects can be identified based on the last year load forecast, which helps in identifying overloaded feeders, main distribution substations, and grid stations. Overall study to relieve overloaded feeders and main distribution substations shall be carried out in coordination between DED and Electricity Departments considering future substation projects.

6.6. Schedule of On-Going Grid Station and Main Distribution Substation Projects

This information indicates schedule completion of on-going (under construction) grid station and main distribution substation projects which assists to plan the completion of the associated Distribution System projects at the proper time for immediate utilization.

6.7. Future Grid Station and Main Distribution Substation projects

This information indicates the Five-Year Plan Projects proposals of sub-transmission network, which involve sub-transmission lines, new substations and upgrading of existing substations that are identified with allocation of budget. These projects are essential to anticipate possible future project proposals for Distribution System.

6.8. Updated Distribution Network Operational Diagram

Updated single line diagrams (SLDs) of feeders and their interconnections, showing all new modification and previous year executed system

improvements, shall be provided by Electricity Departments. SLDs shall indicate substation name, feeder name, breaker number, conductor size and type, cable length, transformers and their capacity and normal open point(s).

Single line diagrams are used to see modifications and changes done on distribution network in the previous year as well as to help in the process of proposing future system improvement projects for the distribution network.

6.9. Updated Distribution Network Geographical Layout

Distribution network geographical layout shall be prepared and updated by Electricity Departments. These layouts shall indicate substations, primary feeders, transformers and scale of drawing.

For planning purposes, it is preferred to have these layouts in scale of 1:5000 or above. Updated layouts shall be kept ready up on the request of DED or shared electronically.

Distribution network geographical layouts help in visualizing the network and to make the most economical alternative system improvement projects.

6.10. Area Layout Drawings for Plot Plan Development

Electricity Departments shall provide three (3) colored copies of area layout drawings showing all area development/new plot plans during the forecast period. Area development plans provide the basic information for the development of network plans.

Details of the new plot plans, such as total number of lots, anticipated total demand, source of supply and approved budget year shall be included in **Form 8** mentioned in section 6.3. above

7.0 PEAK LOAD ASSESSMENT OF GRID STATIONS, MAIN DISTRIBUTION SUBSTATIONS, AND FEEDERS

The absolute maximum of peak readings of substations transformers and feeders, which are collected by Electricity Departments or recorded through SCADA/LDC is not necessarily the real peak load, especially in loop systems. This is because of load transferability between interconnected feeders or substations during contingency. Moreover, other factors such as, human errors and faulty demand meters might affect quality and accuracy of peak readings. Therefore, analysis and assessment of peak readings shall be carried out by DED to get the correct yearly peak load of both feeders and substations.

7.1. Assessment of Feeders Peaks

Assessment of peak load of feeders is done based on the collected data from Electricity Departments areas or from SCADA utilizing **Form 7**.

Assessment of peak load for radial feeders is much easier compared to loop system. In radial system, assessment can be done by selecting the highest recorded peak during the whole year after ignoring up-normal readings which might be due to human or device errors.

For loop system, assessment shall be done loop-wise (considering coincident summation of peaks on loop) to overcome the effects of load transfer. Refer to **Appendix D** for a sample of assessment of peak load for interconnected feeders.

Other factors shall be looked to during the assessment of feeders' peak loads such as, historical peak loads and forecasted peak load of the specific feeder.

7.2. Assessment of Substations Peaks

Peak load on substations transformers can be assessed by applying following formula:

Assessed Transformer Peak = $\sum$ *assessed feeder peak of each TF * C.F.*

Where,

C.F. is the coincident factor, which can be considered in the range of 0.9 – 1.0 depends on the nature of the load in a specific area. A C.F. of 0.95 is preferable between the summation of feeders load and transformer load.

Coincident factor based on past data or history for each substation can also be utilized.

After getting transformers peak load, substation peak load can be then found through multiplying the sum of assessed transformers peak loads by another coincident factor, which is usually around 0.98.

However, if two transformers in a substation are connected in parallel, assessment of substation peak load shall be first found through following formula:

Assessed Substation Peak = $\sum$*assessed feeder peak of both TF's * C.F.*

Then,

Assessed transformer peak = (*Assessed Substation Peak) / 2*

Assessed transformer and substation peaks can be counter checked thru SCADA readings.

Transformers manual recorded readings taken by operators can also assist in the assessment and can be utilized as counter-check.

Appendix E shows a sample of a substation peak load assessment.

8.0 LOAD FORECAST PROCESS AND ANALYSIS

In this section, main parameters in load forecast process and methods/techniques applicable in Saudi Electricity Company is explained in line with the software applied.

8.1. Main Parameters of Load Forecast

Main parameters considered during preparation of load forecast are followings:

1. Normal growth
2. Considerable customer forecast/development of new plot plans
3. Spot loads (Bulk Customer)
4. Load transfer due to network plan and system improvement projects.

Details on the above main parameters are explained in section 6.0 of this guideline.

Explanation on how to incorporate these factors in load forecast process would be demonstrated in section 8.2 below.

8.2. Load Forecast Methods and Techniques

There are different methodologies and techniques used for load forecast. Since electrical distribution network is a dynamic system (changeable due to load transfer on the level of feeders and substations), there is no pure technique that can be directly applied to predict loads in future years. However, modified and customized techniques can be useful for this purpose.

In order to forecast loads on distribution networks of Saudi Electricity Company (SEC), *a modified multiple regression method* is recommended to be utilized.

Multiple regression method, which is a type of trending methods, is used to find out growth factor by analyzing the trend of historical load data and then extrapolating past load growth patterns into the future. Trending encompasses a number of different forecasting methods that apply the same basic concept -- predict future peak load based on extrapolation of past historical loads. Many mathematical procedures have been applied to perform this projection, but all share a fundamental concept; they base their forecast on historical load data alone (Figure 8.1).

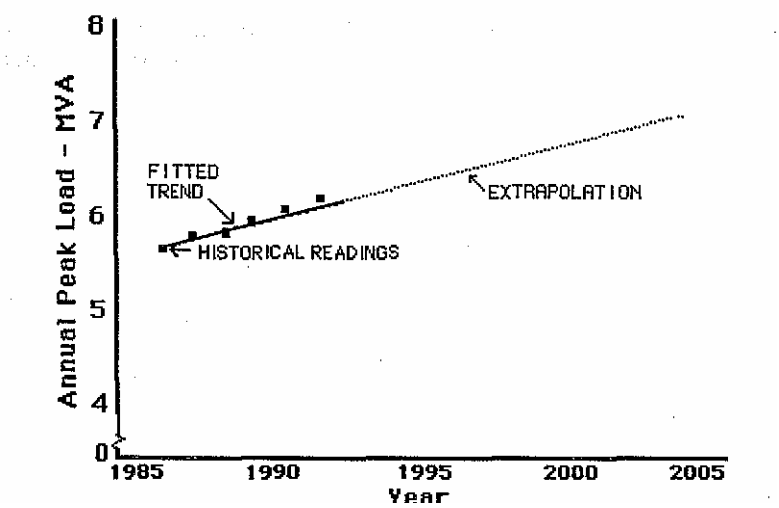


Figure 8.1 Trending methods project future load values by trending-- extrapolating the long-term trend of past load values into the future, as illustrated here.

In general, the curve fit is applied to the annual peak load data. There are two reasons for this. First, annual peak load is the value most important to planning, since peak load most strongly impacts capacity requirements. Second, annual peak load data for facilities such as substations and feeders is usually fairly easy to obtain.

It is called “modified multiple regression method” because it incorporates some other factors, such as load transfer and spot load, in order to forecast future loads. Following formula is developed for this purpose:

Forecasted load for next year (N+1) = [(current year (N) peak * (1+normal growth factor)) + Spot load ± load transfer] *…. (1)*

And for year N+2

Forecasted load for year (N+2) = [(forecasted load for year (N+1) * (1+normal growth factor)] + Spot load ± load transfer)] *.. (2)*

And so on … for following years

The above formula can be used to predict load on feeders or substations.

Steps of Load Forecast Process

1. Growth Factor Calculation

Growth factor can be calculated by the following formula:

$$G.F = \left[\left[\left(\frac{A}{B}\right)^{\frac{1}{n}}\right] - 1\right] * 100 \qquad \ldots\ldots\ldots (3)$$

Where,

G.F. = Historical trends in growth (% Growth)
A = Current year peak.
B = Peak of the year (n), which precedes forecasted year by n years.
N = No. of preceding years – No. of historical data (preferably 6 years for 5-year load forecast)

Appendix F shows an example on how to apply above formula.

Since loads of feeders and substations are sometimes experienced frequent change from year to another year due to load transfer, a growth factor is recommended to be calculated on zone or district levels. Then, it can be reflected on the feeders or substations. Moreover, the developed MS Excel load forecast program facilitates assigning a separate growth factor for each single feeder, as it will be shown in section 8.3.

Derived growth factor on zone or district levels usually incorporates spot loads of past years. Therefore, it is more effective to subtract spot loads from historical data before finding growth factor. This requires maintaining a database of energized spot loads in each year.

2. Incorporating Load Transfer

Proposed load transfer from overloaded substations to the nearby lightly loaded substations or to the new substations shall then be entered in the MS Excel load forecast program.

Formulas 2 & 3 shows that load transfer can be positive or negative. Positive sign means that some loads would be transferred to the feeder or substation while negative sign means shifting some loads from the feeder or substation.

3. Incorporating Spot Loads

Spot loads (greater than 1.0 MVA) shall also be incorporated. A load of 1.0 MVA can be considered as a spot load in some areas while it can be considered as a normal growth in some other area. This can be judged be area responsible engineer.

Spot load can be allocated in one single year or it might be distributed for more than one year depending on its nature and type (i.e. industrial, commercial, residential …). For example, industrial load most probably comes in one year while commercial load might require many years to materialize.

Considerable loads of normal customers, which are due to new plot plans development can also be considered as a spot load. Normal increase of new or existing customers would be covered by the normal growth.

8.3. Load Forecast Software

To generate the forecast, a MS Excel spreadsheet is developed. A sample sheet is shown in **Appendix G**. The main parts of this spreadsheet are as follows:

Columns 1-2*:* Substation name and feeders information (No., name).

Columns 3-4*:* Historical data. Some hidden columns show also more historical data.

Columns 5-6*:* Current year actual demand in Amps & MVA. If some areas do not have Amps readings, MVA readings are enough.

Columns 7-11*:* Demand forecast for the 5-years forecast period. Formulas (1) & (2) mentioned in section 8.2 are utilized for demand forecast calculation incorporating all parameter.

Columns 12-16*:* Under these columns, load transfer shall be incorporated

Columns 17-21*:* Spot load shall be entered under these columns.

***Columns 22-26**:* Growth Factor can be specified for each feeder separately regardless of general district or substation growth factor. General trend growth factor of substation is shown in row # 2 of the spreadsheet in Appendix G.

***Column 27**:* This column shows codes for any remarks which indicate any load transfer or spot load incorporated in the load forecast. Full remarks are shown down in the last rows of each substation load forecast spreadsheet.

The developed MS Excel Load Forecast Spreadsheets have also other information, such as substation and feeder loop codes, bus number, connected load in each feeder and breakers data (no. of active, spare or substation service breakers). This information can be explored through the electronic copy of this program

Although this developed Excel program fulfills and assists much in producing load forecast, advanced data based software shall be developed.

9.0 LOAD FORECAST REPORTS

The load forecast report is the output of load forecast process described in section 8.0 above. In this section contents and formatting of two types of reports (feeders and substations load forecast reports) are described.

9.1. Feeder Load Forecast Report

This report will be prepared by DEDs for Electricity Departments and Planning Department\Distribution Services. The report shows forecasted demand of feeders for the horizon of forecast. Also, it indicates spot loads and load transfer due to system improvement projects.

Electricity Departments shall utilize and refer to the report for the following planning purposes and activities:

- Power supply studies for customers whose load up to 4.0 MVA.

- Preparing contingency plans at feeders and transformers levels.
- Reinforcement/enhancement of MV network.

DED's shall send a copy of this report to Planning & Development Department/Distribution Services Sector for the purpose of maintaining a database.

Form # 10 shows the format of this report.

9.2. Substations Load Forecast Report

DED's shall prepare substations load forecast report and submitted it to Planning Department\Distribution Services for their consolidation. This report shall include following parts:

- Summary of forecasted demand in MW for each main district belongs to each Electricity Department, as per **Form 1.**
- Summary of forecasted energy sales in MWH for each operating area, as per **Form 2.** (*DED's shall collect these data from Customer Affairs Departments*).
- Grid stations and main distribution substations, which exceeded 100% of their firm capacity during current year peak period. **Forms 4 and 5** shall be used.
- Grid stations and main distribution substations, which are expected to exceed 100% of their firm capacity during next 5 years plan period. **Forms 4A and 5A** shall be used.
- List of bulk customers (> 4.0 MVA), which are expected to be energized during forecast period. **Form 9A** shall be used.
- 5-Year load forecast of main distribution substations, incorporating any important remarks or relieving projects for overloaded substations. **Form 6A** shows a sample format.
- 5-Year load forecast of grid stations, incorporating any important remarks or relieving projects for overloaded substations. **Form 6B**

shows a sample format.

- List of required grid stations as shown in **Form 11.**
- List of required main distribution substations as shown in **Form 12.**

PD/DS shall review reports submitted by DED's and consolidate them in one report as 5-Year Load Forecast of all Operating Areas. This report shall be then submitted to the Higher Management and concerned departments with a summary of most important highlights and required future projects.

FORMS

Form 1

SUMMARY OF FORECASTED DEMAND (MW)

Electricity Depts.	Offices		MW Demand					
			Actual	Forecasted				
			2004	2005	2006	2007	2008	2009
Summary of COA Demands								
Riyadh City	North - Dariah							
	Khurais							
	South							
	East							
Riyadh Rural								
Kharaj	Kharaj							
	Dwaser							
Dawadmi								
Qassim								
Hail								
Summary of EOA Demands								
Dammam *	Dammam							
	Khobar							
	Qatif							
Hofuf *	Hofuf							
	Villages							
	Abqaiq							
North *	Nariyah							
	Khafji							
	Jubail							
	Hafer							
Forth	Aljuf	Skaka						
		Daumat						
	Rafha							
	Arar							
	Qurayyat	Qurayyat City						
		Tabarjal						
		Turaif						
Summary of WOA Demands								
Jeddah								
Makkah	**Makkah**							
	Khulais							
	Al Laith							
Madinah	**Madinah**							
	Al Olaa							
	Amluj							
	Al Hunakiah							
	Khaibar							
	Mahd Al Dahab							
	Al Wajah							
Tabuk	**Tabuk**							
	Debaa							
	Taima							
	Al Qulaibah							
Taif	**Taif**							
	Al Khurmah							
	Raniah							
	Turbah							
Summary of SOA Demands								
Asir	**Asir**							
	Bisha							
	Tathleeth							
Baha	**Baha**							
	Tihama							
Jazan	**Jazan**							
	Farasan							
Najran	**Najran**							
	Yadamah							
	Sefah							
	Kharkher							
	Sharurah							

Form 2

SUMMARY OF FORECASTED ENERGY SALES (MWH)

Opreating Area	Actual MWH Sales		Forecasted MWH Sales				
	2003	2004	2005	2006	2007	2008	2009
COA							
EOA							
WOA							
SOA							
Total							

Form 3

SUMMARY OF REQUIRED SUBSTATION PROJECTS (NO's.)

Summary of COA

Opreating Area	Area	≥110kV																				<110kV										
		New S/S Projects									Reinforcement Projects									New Distribution S/S Projects									Distribution S/S Reinforcement Projects				
		2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Riyadh City	North & Dariah																														
	Khurais																														
	South																														
	East																														
	Total																														
Riyadh Rural																															
Kharj																															
Dawadmi																															
Qassim																															
Hail																															
Total for COA																															

Summary of EOA

Dammam	Dammam																														
	Khobar																														
	Qatif																														
Hofuf																															
North																															
Forth																															
Total for EOA																															

Summary of WOA

Jeddah																															
Makkah																															
Madinah																															
Taluk																															
Taif																															
Total for WOA																															

Summary of SOA

Asir																															
Baha																															
Jazan																															
Najran																															
Total for SOA																															

Form 4

GRID STATIONS EXCEEDED 100% OF THEIR FIRM CAPACITY DURING CURRENT YEAR PEAK PERIOD

Area	Dist	SUBSTATION NAME	Capacity (MVA)		Actual 20__	Loading %	Remarks
			Installed	Firm			

Form 4A

GRID STATIONS EXCEEDED 100% OF THEIR FIRM CAPACITY DURING NEXT FIVE YEARS FORECAST PERIOD

Area	Dist	SUBSTATION NAME	Capacity (MVA)		Actual	Forecast Loading %					Remarks
			Installed	Firm	2004	2005	2006	2007	2008	2009	

Form 5

GRID STATIONS EXCEEDED100 % OF THEIR FIRM CAPACITY DURING CURRENT YEAR PEAK PERIOD

Area	Dis.	Grid Station	SUBSTATION NAME	Location	Capacity (MVA)		Actual 20__	Loading %	Remarks
					Installed	Firm			

Form 5A

GRID STATIONS EXCEEDED 100% OF THEIR FIRM CAPACITY DURING NEXT FIVE YEARS FORECAST PERIOD

Grid Station	SUBSTATION NAME	Location	Capacity (MVA)		Actual	Forecast Loading %					Remarks
			Installed	Firm	2004	2005	2006	2007	2008	2009	

Form 6A

MAIN DISTRIBUTION SUBSTATIONS-FIVE YEARS LOAD FROECAST (MVA)

No.	Dist	SUBSTATION NAME	Capacity (MVA)		DEMAND (MVA)						Remarks
					Actual	Forecast					
			Installed	Firm	2004	2005	2006	2007	2008	2009	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Form 6B

GRID STATIONS FIVE YEARS LOAD FORECAST (MVA)

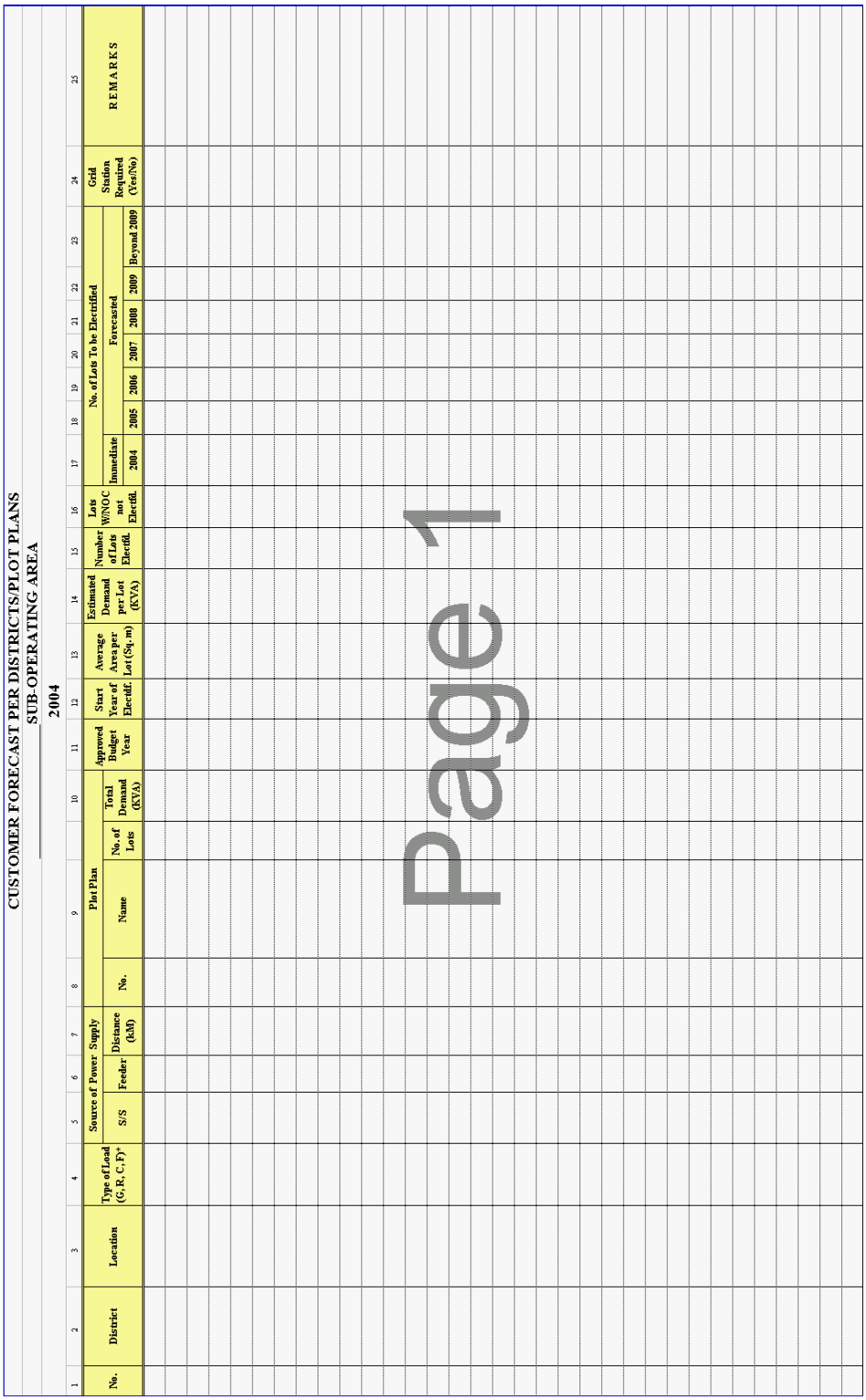
No.	Dist	Grid Station Name	Capacity (MVA)		DEMAND (MVA)						Remarks
					Actual	Forecast					
			Installed	Firm	2004	2005	2006	2007	2008	2009	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Form 7

FEEDERS AND TRANSFORMERS LOAD READINGS

| Loop Code | Grid Station | | Previous Year Peak (Amp) | 2003 PEAK LOAD (Amp) | | Maximum Demand | | |

Form 8



CUSTOMER FORECAST PER DISTRICTS/PLOT PLANS

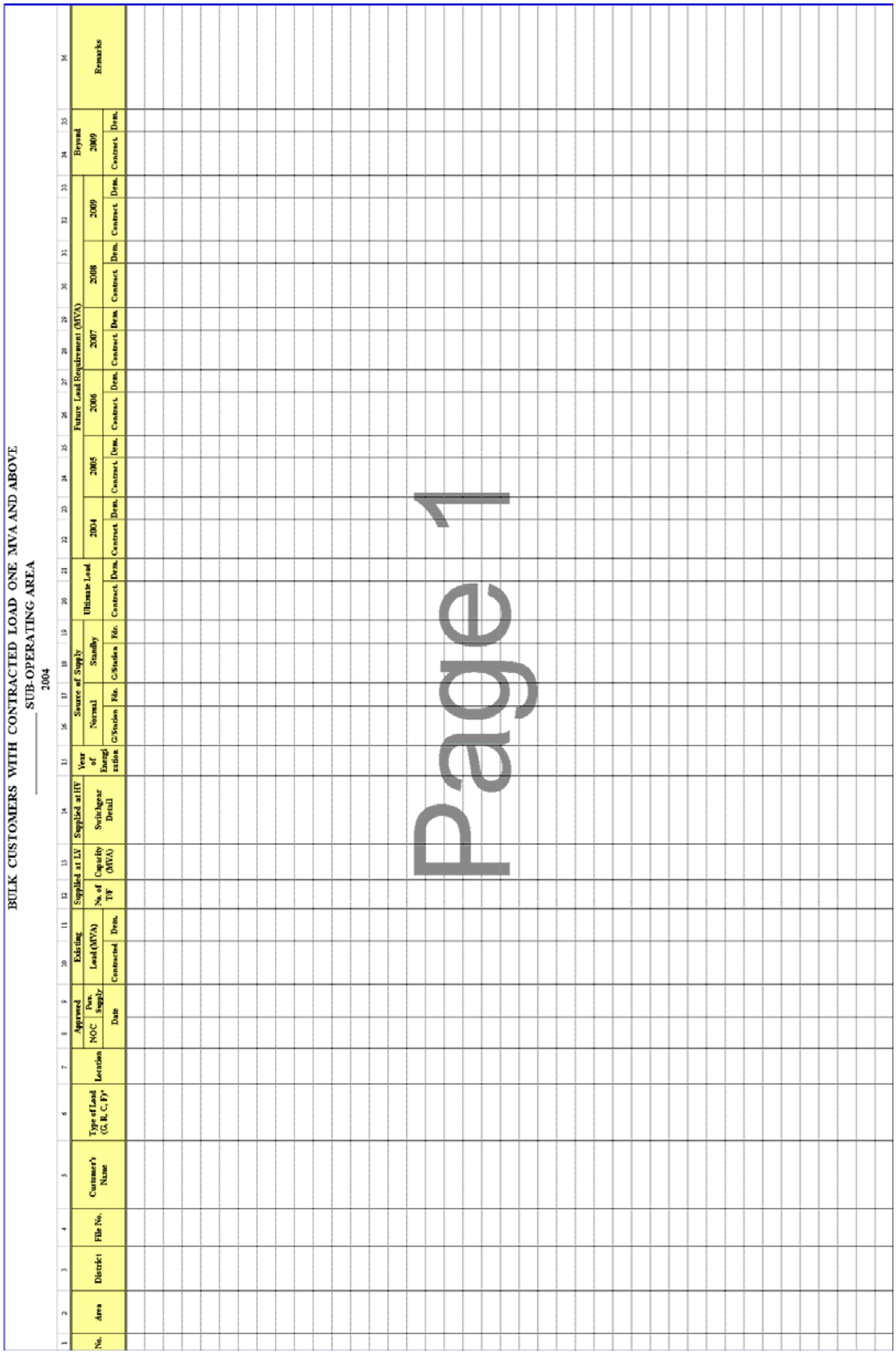
SUB-OPERATING AREA

2004

No.	District	Location	Type of Load (G, R, C, F)+	Source of Power Supply			Plot Plan				Approved Budget Year	Start Year of Electfd.	Average Area per Lot (Sq. m)	Estimated Demand per Lot (KVA)	Number of Lots Electfd.	Lots W/NOC not Electfd.	No. of Lots To be Electrified						Grid Station Required (Yes/No)	REMARKS
				S/S	Feeder	Distance (kM)	No.	Name	No. of Lots	Total Demand (KVA)							Immediate	Forecasted						
																	2004	2005	2006	2007	2008	2009 Beyond 2009		

Page 1

Form 9


BULK CUSTOMERS WITH CONTRACTED LOAD ONE MVA AND ABOVE
SUB-OPERATING AREA
2004
No.
Area
District
File No.
Customer's Name
Type of Load (G, R, C, F)*
Location
Approved
NOC
Date
For Supply
Existing Load (MVA)
Contracted
Dem.
Supplied at HV
No. of TF
Capacity (MVA)
Supplied at LV
Switchgear Detail
Year of Energization
Source of Supply
Normal
G'Station
Fdr.
Standby
G'Station
Fdr.
Ultimate Load
Contract
Dem.
Future Load Requirement (MVA)
2004
Contract
Dem.
2005
Contract
Dem.
2006
Contract
Dem.
2007
Contract
Dem.
2008
Contract
Dem.
2009
Contract
Dem.
Beyond 2009
Contract
Dem.
Remarks
Page 1

Form 9A

LIST OF BULK CUSTOMERS (>= 4 MVA CONTRACTED LOAD)

Area	Div.	No.	Customer Name	Type	Location	Source S/S	Actual	Forecasted Load (MVA)				
							2004	2005	2006	2007	2008	2009

Form 10

FEEDERS FIVE-YEARS LOAD FORECAST (AMPERES)

Feeder		Historical Data		Actual Demand	Forecasted Demand					REMARKS
		2002	2003	2004	2005	2006	2007	2008	2009	
No.	Name	Amp	Amp	Amp	Amperes					
Substation Name: ABC										
B311	A	110	120	130	133	137	139	142	145	
B312	Behari	180	200	220	0	0	0	0	0	A1
B313	C	50	60	60	61	63	64	66	67	
B314	Dirah-2	180	200	210	215	221	225	230	235	
B315	E	60	70	60	61	63	64	66	67	
B316	Spare									
B317	F	160	170	190	195	49	50	52	53	B1
B318	Spare									
B319	Spare							86	87	D1
Fdr. sum		740	820	870	666	533	543	641	654	
T501 (A301)		600	670	750	574	459	468	552	564	
CF		0.81	0.82	0.86	0.86	0.86	0.86	0.86	0.86	
CF Manual Override										
B320	Spare									
B321	Spare					84	127	130	133	G1, H1
B322	G	80	90	110	113	116	118	120	123	
B323	H									
B324	I	140	160	180	77	79	81	83	84	A2
B325	J	140	150	150	154	158	161	164	168	
B326	K	110	120	140	143	147	150	153	157	
B327	Spare									
B328	L	110	100	160	0	0	0	0	0	A3
B329	Serv. T/F									
Fdr. sum		580	620	740	487	583	637	651	664	
T502 (A302)		600	670	750	494	591	645	660	673	
CF		1.03	1.08	1.01	1.01	1.01	1.01	1.01	1.01	
CF Manual Override										
Fdr. Total		1320	1440	1610	1153	1116	1180	1292	1318	
T1+T2 (NC)		1200	1340	1500	1074	1040	1099	1203	1228	
T1+T2 (C)		1200	1340	1500	25.7	24.8	26.3	28.8	29.4	
CF		0.91	0.93	0.93	0.93	0.93	0.93	0.93	0.93	
CF Manual Override										

A1: To B315 of BBB S/S
A2: To B331 of BBB S/S
A3: To B320 of BBB S/S
B1: To B311 of CCC S/S
D1: From B340 of DDD S/S

Form 11

LIST OF REQUIRED GRID STATIONS PROJECTS

Area	Div.	Name of Grid Station	Proposed Capacity	Proposed Completion Date	Budget Year

Form 12

LIST OF REQUIRED MAIN DISTRIBUTION SUBSTATIONS

Area	Div.	Name of Grid Station	Proposed Capacity	Proposed Completion Date	Budget Year

APPENDIXES

Appendix A

FLOW CHART AND TIMING OF LOAD FORECAST PROCESS

DATA COLLECTION

1. Historical Data
2. Peak demand of feeders and grid station transformers.
3. Spot load (bulk customers).
4. Customers Forecast.
5. System Improvement Projects (5-Year Network Plan).
6. Schedule of on-going grid station projects.
7. Future grid stations projects.
8. Updated distribution network operational diagram.
9. Updated distribution network geographical layout.
10. Area layout drawings for plot plan development.

Note:
*DED's shall have all required data ready by **end of September** each year*

↓

MONITORING AND ASSESSMENT OF PEAKS ON G/S'S AND FEEDERS

↓

LOAD FORECAST PROCESS

↓

REPORTING OF G/S'S LOAD FORECAST WITH RECOMMENDATIONS TO PD/DS

Note:
*DED's shall submit their G/S's load forecast report to PD/DS by **end of December** each year*

↓

PD/DS REVIEW & CONSOLIDATE

↓

FINAL REPORT TO BE FORWARDED TO TRANSMISSION SECTOR

Note:
*PD/DS shall submit the final consolidated report to Transmission Sector **by end of January***

Appendix B

MAJOR ACTIVITIES OF LOAD FORECAST PROCESS AND THEIR CORRESPONDING DUE DATA

ACTIVITIES	ACTION BY	SUBMITTED DATE	SUBMITTED TO	January	February	March	April	May	June	July	August	September	October	November	December	January
Data collection	Ele. Depts/ DEDs	End of September	DEDs													
Analysis of peak on substations and feeders	Ele. Depts/ DEDs															
Load forecasting process	DEDs															
Reporting of substation's load forecast with recommendations.	DEDs	End of December	PD/DS													
Review and consolidate the final report	PD/DS															
Submittal of final load forecast report.	PD/DS	End of January	Transmission Sector													

Note:

Above time table is suitable for Normal Scenario. For Special Scenario, collection of data for peak load of feeders and substations shall start from November of previous year. Other activities and corresponding due date indicated in above table will remain the same.

Appendix C1

Table – 1.0

Calendar for Ramadhan with respect to Gregorian Month

Year		Start	End
Hijira	Gregorian		
1424H	2003	26-10-2003	24-11-2003
1425H	2004	15-10-2004	13-11-2004
1426H	2005	05-10-2005	01-11-2005
1427H	2006	24-09-2006	21-10-2006
1428H	2007	13-09-2007	12-10-2007
1429H	2008	01-09-2008	30-09-2008
1430H	2009	22-08-2009	19-09-2009
1431H	2010	12-08-2010	09-09-2010
1432H	2011	01-08-2011	30-08-2011
1433H	2012	21-07-2012	18-08-2012
1434H	2013	10-07-2013	07-08-2013
1435H	2014	**29-06-2014**	**27-07-2014**
1436H	2015	**18-06-2015**	**16-07-2015**
1437H	2016	**06-06-2016**	**16-07-2016**
1438H	2017	**27-05-2017**	**24-06-2017**
1439H	2018	**17-05-2018**	**14-06-2018**
1440H	2019	**16-05-2019**	**04-06-2019**
1441H	2020	**24-04-2020**	**23-05-2020**
1442H	2021	13-04-2021	12-05-2021
1443H	2022	03-04-2022	01-05-2022
1444H	2023	23-03-2023	21-04-2023
1445H	2024	12-03-2024	09-04-2024
1446H	2025	01-03-2025	30-03-2025
1447H	2026	19-02-2026	19-03-2026
1448H	2027	08-02-2027	09-03-2027
1449H	2028	28-01-2028	26-02-2028
1450H	2029	16-01-2029	14-02-2029
1451H	2030	15-01-2030	03-03-2030

Table – 1.1

Calendar for Hajj with respect to Gregorian Month

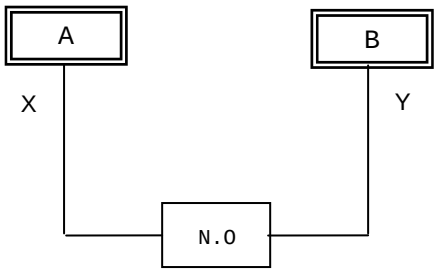
YEAR	START	END
1424H	23-01-2004	21-02-2004
1425H	11-01-2005	09-02-2005
1426H	31-12-2005	29-01-2006
1427H	20-12-2006	18-01-2007
1428H	09-12-2007	07-01-2008
1429H	27-11-2008	26-12-2008
1430H	16-11-2009	15-12-2009
1431H	05-11-2010	14-12-2010
1432H	25-10-2011	23-11-2011
1433H	13-10-2012	11-11-2012
1434H	02-10-2013	31-10-2013
1435H	21-09-2014	20-10-2014
1436H	10-09-2015	09-10-2015
1437H	29-08-2016	27-09-2016
1438H	18-08-2017	16-09-2017
1439H	07-08-2018	05-09-2018
1440H	27-07-2019	25-08-2019
1441H	15-07-2020	13-08-2020
1442H	04-07-2021	02-08-2021
1443H	23-06-2022	22-07-2022
1444H	16-06-2023	11-07-2023
1445H	31-05-2024	29-06-2024
1446H	20-05-2025	18-06-2025
1447H	09-05-2026	07-06-2026
1448H	28-04-2027	27-05-2027
1449H	16-04-2028	15-05-2028
1450H	05-04-2029	04-05-2029
1451H	25-03-2030	23-04-2030

Appendix D

EXAMPLE OF LOOPED FEEDERS PEAK LOAD ASSESSMENT

Loop Code	Grid Station		Month												Peak Load	
	S/S	FDR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAX	ASSESSED
XY	A	X	110	120	140	145	**100**	160	180	**80**	170	150	120	100	180	180
XY	B	Y	90	100	120	125	**180**	135	145	**240**	130	125	120	110	240	145
Coincident Loop Total (Amps)			200	220	260	270	280	295	325	320	300	275	240	210	420	325

SINGLE LOOP CASE



Notes:

1. As you see in above table, the maximum coincident total load on the loop xy is 325 Amps. Therefore, total of peaks of both feeders shall be around this figure. If you will choose the absolute max readings on each feeder, the total will be 420 Amps which is not correct.

2. You may notice that there is a load transfer from FDR x to FDR y during *May* and *August*. Hence, these two readings at May and August might be ignored. From the analysis, the real max peaks of FDRs x and y are 180 and 145 Amps, respectively.

3. Similar analysis can be done for T-loop and other mesh system.

4. Codes can be assigned for each loop to have proper identification and to facilitate getting loop summation through a software such as MS Excel or Access or others. MS Excel can help in this process through “Subtotals” function.

Appendix E

EXAMPLE OF SUBSTATION PEAK LOAD ASSESSMENT

Loop Code	Grid Station Fd	Ld.	Month Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max	Assessed
	ABC S/S, 2X20MVA, 69/13.8KV															
	F1		110	120	140	145	100	160	180	80	170	150	120	100	180	180
	F2		90	100	120	125	180	135	145	240	130	125	120	110	240	145
	Feeders Sum		200	220	260	270	280	295	325	320	300	275	240	210	420	325
	T1 Load(A)		150	180	210	245	270	270	315	280	260	250	215	185	315	285
	C.F		.75	.82	.81	.91	.96	.92	.97	.88	.87	.91	.90	.88	.75	.88
	F3		52	75	80	100	135	130	128	125	122	110	95	76	135	135
	F4		70	90	100	140	138	140	260	140	140	135	120	100	260	140
	Feeders Sum		122	165	180	240	273	270	388	265	262	245	215	176	395	275
	T2 Load(A)		145	180	210	240	270	270	320	280	260	250	210	185	320	285
	C.F		1.19	1.09	1.17	1.00	.99	1.00	.85	1.06	.99	1.02	.98	1.05	.81	1.04
	Feeders Total		322	385	440	510	553	565	713	585	562	520	455	386	815	600
	T1+T2 (NC)		295	360	420	485	540	540	635	560	520	500	425	370	635	570
	C.F		.92	.94	.95	.95	.98	.96	.89	.96	.93	.96	.93	.96	.78	0.95

The above sample table shows two transformers (T1 & T2) of grid station ABC, which are connected in parallel. F1 & F2 are connected to T1, while F3 & F4 are connected to T2 of substation ABC.

Assessed substation peak = ∑*Assessed feeder peak of both TF's * C.F.*

∑*Assessed feeder peak of both TF's = 600 Amps*

If historical data of C.F. for substation ABC is available, it shall be considered. If not, a value of 0.95 shall be considered.

Then, assessed substation peak = 600 * 0.95 = 570 Amps

Assessed transformers peak = 570 / 2 = 285 Amps (they are equal because they are in parallel)

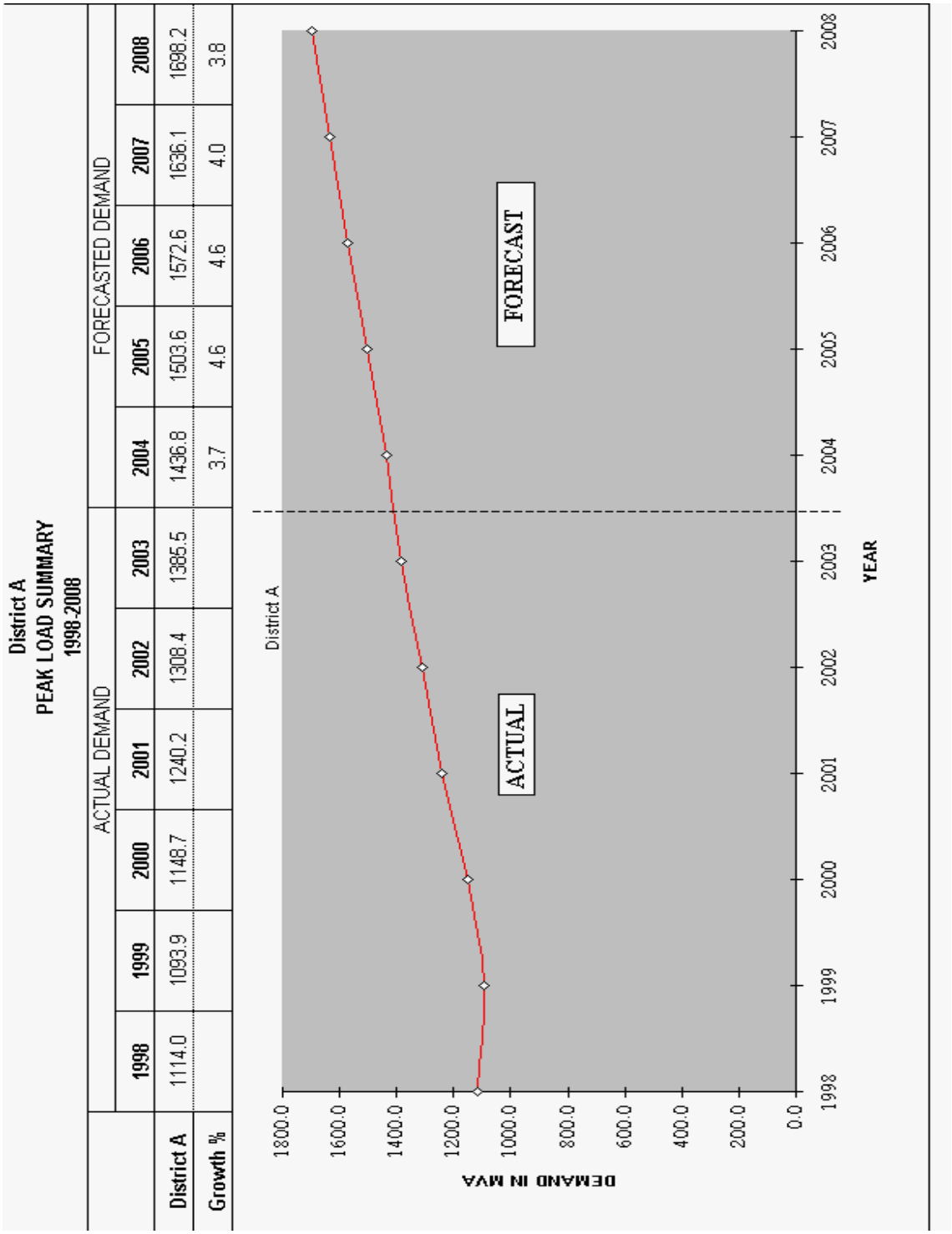
Note that F4 has up-normal reading (260 Amps) during July, which might be due to load transfer

from a feeder of another substation.

Appendix F

District A
PEAK LOAD SUMMARY
1998-2008

	ACTUAL DEMAND							FORECASTED DEMAND						
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
District A	1114.0	1093.9	1148.7	1240.2	1308.4	1385.5	1436.8	1503.6	1572.6	1636.1	1698.2
Growth %							3.7	4.6	4.6	4.0	3.8



Appendix G

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27					
Growth Factor :						0.0243	0.0255	0.0200	0.0220	0.0210																					
13.8 kV Bus Voltage																															
Feeder		Historical Data		Actual Demand		Demand Forecast					Load Transfer (Coinc. Demand)					Spot Load (Coincident Demand)					Growth Factor									
						1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6		
No.	Name	2002	2003	2004		2005	2006	2007	2008	2009		2005	2006	2007	2008	2009		2005	2006	2007	2008	2009		2005	2006	2007	2008	2009		RMRK
		Amp	Amp	Amp	MVA	(MVA)	(MVA)	(MVA)	(MVA)	(MVA)		(MVA)	(MVA)	(MVA)	(MVA)	(MVA)		(MVA)	(MVA)	(MVA)	(MVA)	(MVA)		pu	pu	pu	pu	pu		
											A	B	C	D	E	F	G	H	I	J										
Substation Name: ABC					2x25/30MVA, 69/13.8kV																										
B311	A	110	120	130	3.11	3.18	3.26	3.33	3.40	3.47																					
B312	Behari	180	200	220	5.26	0.00	0.00	0.00	0.00	0.00	-5.26																			A1	
B313	C	50	60	60	1.43	1.47	1.51	1.54	1.57	1.60																					
B314	Dirah-2	180	200	210	5.02	5.14	5.27	5.38	5.50	5.61																					
B315	E	60	70	60	1.43	1.47	1.51	1.54	1.57	1.60																					
B316	Spare																														
B317	F	160	170	190	4.54	4.65	1.18	1.20	1.23	1.26		-3.50																	B1		
B318	Spare																														
B319	Spare								2.04	2.09				2.00															D1		
Fdr. sum		740	820	870	20.80	15.91	12.73	12.93	15.31	15.63	-5.26	-3.50		2.00																	
T501 (A301)		600	670	750	17.93	13.72	10.97	11.19	13.20	13.48											-0.23	-0.20	0.02	0.18	0.02						
CF		0.81	0.82	0.86	0.86	0.86	0.86	0.86	0.86	0.86																					
CF Manual Override																															
B320	Spare																														
B321	Spare																2.00	1.00											G1, H1		
B322	G	80	90	110	2.63	2.69	2.76	2.82	2.88	2.94																					
B323	H																														
B324	I	140	160	180	4.30	1.85	1.89	1.93	1.97	2.02	-2.50																		A2		
B325	J	140	150	150	3.59	3.67	3.77	3.84	3.93	4.01																					
B326	K	110	120	140	3.35	3.43	3.52	3.59	3.66	3.74																					
B327	Spare																														
B328	L	110	100	160	3.82	0.00	0.00	0.00	0.00	0.00	-3.82																		A3		
B329	Serv. T/F																														
Fdr. sum		580	620	740	17.69	11.64	13.94	15.22	15.55	15.98	-6.32						2.00	1.00													
T502 (A302)		600	670	750	17.93	11.80	14.13	15.43	15.76	16.10											-0.34	0.20	0.09	0.02	0.02						
CF		1.03	1.08	1.01	1.01	1.01	1.01	1.01	1.01	1.01																					
CF Manual Override																															
Fdr. Total		1320	1440	1610	38.48	27.56	26.67	28.20	30.87	31.52	-11.58	-3.50		2.00			2.00	1.00													
T1+T2 (NC)		1200	1340	1500	35.85	25.52	25.10	26.62	28.97	29.57																					
T1+T2 (C)		1200	1340	1500	35.85	25.67	24.85	26.28	28.76	29.36											-0.28	-0.03	0.06	0.09	0.02						
CF		0.91	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93																					
CF Manual Override																															
A1: To B315 of BBB S/S				A2: To B331 of BBB S/S				A3: To B320 of BBB S/S			B1: To B311 of CCC S/S					D1: From B340 of DDD S/S					G1, H1: Al-Waha Hospital								